Gravatt, Dan

From: Kiefer, Robyn V NWK <Robyn.V.Kiefer@usace.army.mil>
Sent: Monday, July 07, 2014 9:41 AM
To: Gravatt, Dan
Subject: Panel Installation and Secant Pile pictures (UNCLASSIFIED)
Attachments: Secant Pile Constr Process.gif; Secant Pile Constr Process 2.gif; Secant Pile Installation.gif; hydromill cutters with mud.jpg; IMG_0172.jpg; 13-Lindquist PPT [Read-Only].pdf

Classification: UNCLASSIFIED
Caveats: NONE

Dan:

Per our discussion last week. See attached pictures/info for Secant Pile Wall (.gif) Couldn't save the .gif's into another format because file was protected. I've also attached the .pdf that was my source file for the Secant Pile info (originally, it was a power point file).

Also attached are pictures of a panel wall installation (.jpg). Our engineers tell me that when the tool is pulled from the panel excavation, whether it be with a clamshell or a hydromill, slurry and excavation spoil gets spilled everywhere. The pictures shown here are for a hydromill (clamshells are messier) and this is a very clean site because the contract had a requirement for a dedicated "hose man" to constantly wash the mud and slurry back into the excavation panel. This is only possible if you have a concrete platform.

Hope this helps. Let me know if you need other types of pictures for 10 Jul brief.

Thanks,
Robyn

Robyn Kiefer
Project Manager
US Army Corps of Engineers
Office: 816-389-3615
Blackberry: 816-803-5730

Classification: UNCLASSIFIED
Caveats: NONE

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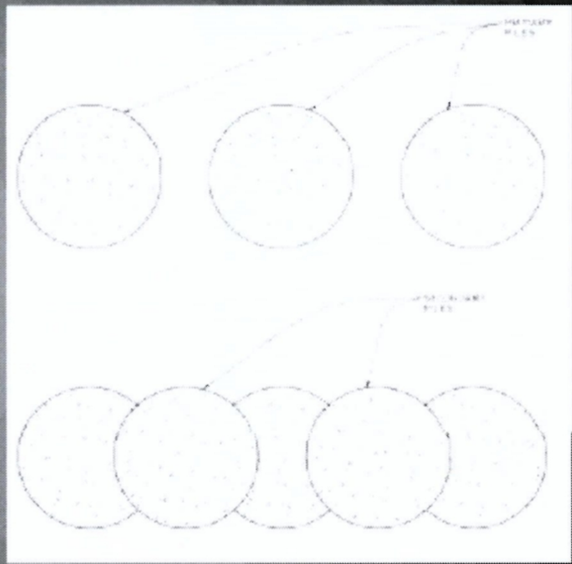
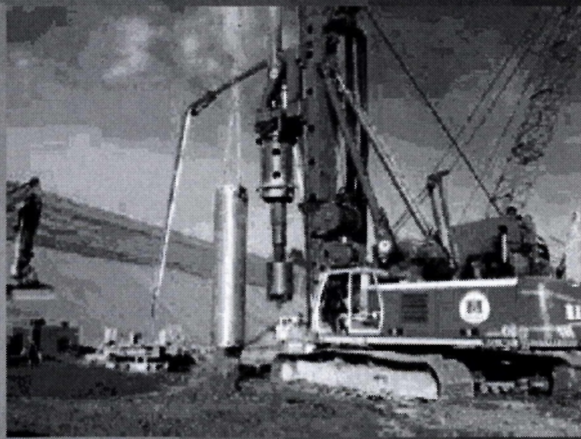
CONSTRUCTION PROCESS

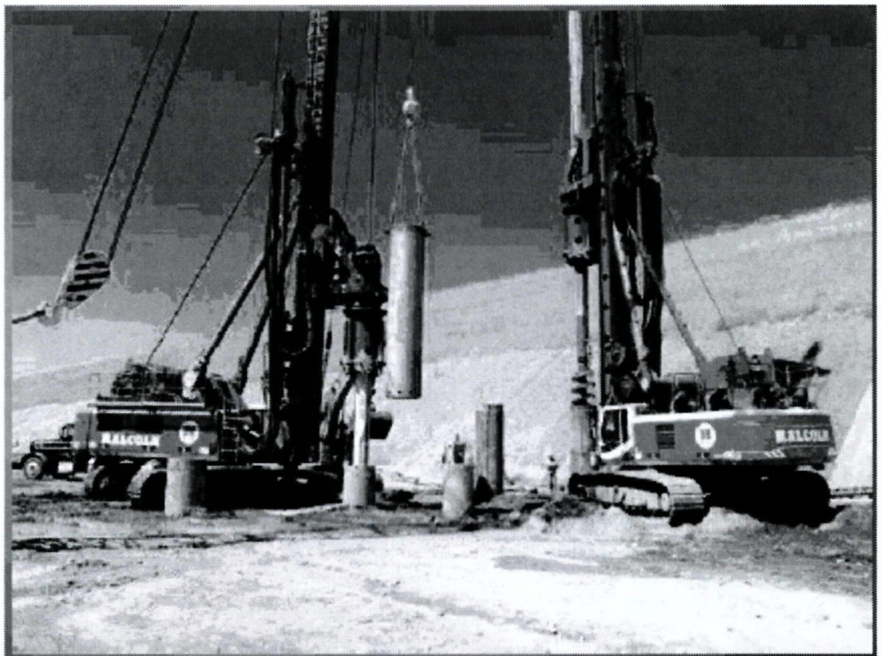
- Alternate primary (initial) and secondary (closure) piles.
- Primary piles are installed first followed by the secondary piles. Secondary piles are "cut in" to the primary piles.
- Piles can be filled with either structural or lean concrete.



CONSTRUCTION PROCESS

- Drilling Methods
  - Kelly drilling: Allows a range of soil and rock tooling to be utilized within a cased hole as the hole is advanced.
  - Sectional heavy wall drill casing, advanced concurrently with the drill tool maintains hole stability and stiffens the drill string.
  - Top drive rotary crawler drills ideally suited for secant pile drilling.
  - Pile diameters: 24"-48".
  - Oscillator attachment can be used to assist casing advance and extraction.





Secant Pile Installation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SECANT PILE SHORING – DEVELOPMENTS IN DESIGN AND CONSTRUCTION

36TH ANNUAL CONFERENCE
ON DEEP FOUNDATIONS
BOSTON 2011

DEEP FOUNDATIONS INSTITUTE
DFI

Eric Lindquist, Ph.D., PE
Rob Jameson

BLCE
BERTI-LINDQUIST CONSULTING ENGINEERS, INC
a Division of Brierley Associates, Inc.

SECANT PILES

- Secant pile walls are formed by constructing a series of overlapping concrete-filled drill holes to form a continuous, relatively watertight wall.

CONSTRUCTION PROCESS

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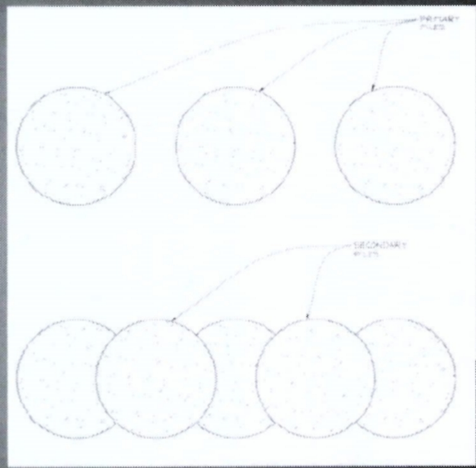

CONSTRUCTION PROCESS

- Drilling Methods
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  - Sectional heavy wall drill casing, advanced concurrently with the drill tool maintains hole stability and stiffens the drill string.
  - Top drive rotary crawler drills ideally suited for secant pile drilling.
  - Pile diameters: 24"-48".
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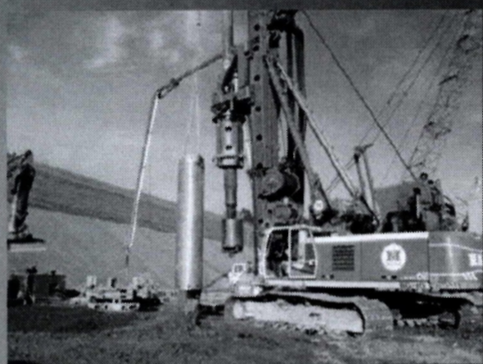
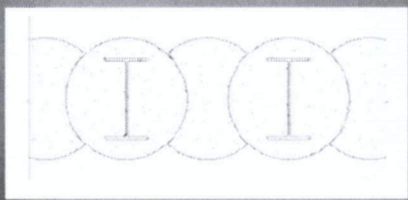
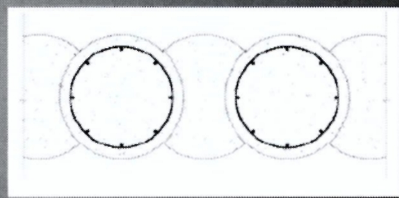


REINFORCING OPTIONS

- Typically secondary piles are reinforced. Much less common to reinforce both the primary and secondary piles.



Wide Flange Insert



Rebar Cage

SECANT PILE APPLICABILITY

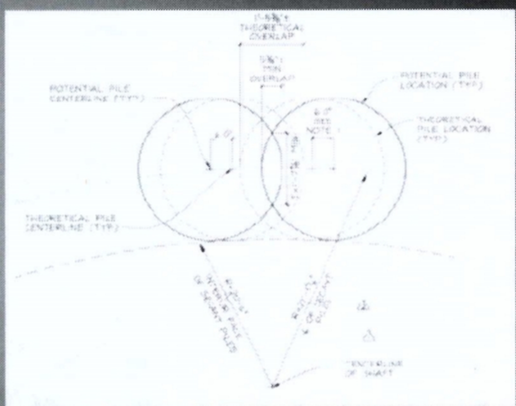
- Groundwater cut-off
- Minimize ground loss
- Applicable for almost all geotechnical conditions, including:
  - Loose, cohesionless soil below the groundwater table
  - Soils with cobbles and boulders
  - Rock, including penetration into hard rock when required

DESIGN CONSIDERATIONS

- Designed and analyzed similar to other "continuous" wall systems (e.g. sheet piles, deep soil mixing)
- Reinforced piles are typically designed to act as beams spanning in the vertical direction.
- Concrete between reinforced elements acts as "lagging."
- Cantilever or restrained (e.g. cross-lot bracing or tiebacks) wall systems are feasible.
- Can also function as unreinforced concrete ring structures with the design based upon the minimum effective compression ring thickness that can be developed by the overlapping piles with installation tolerances considered. Structurally-efficient.

INSTALLATION TOLERANCE

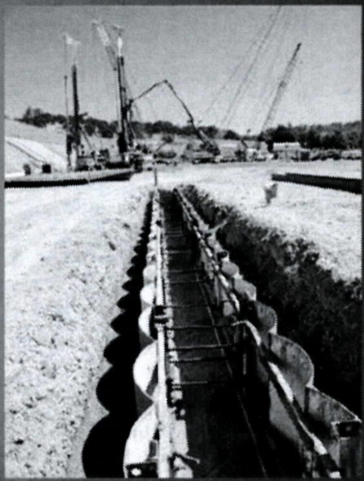
- In order for a secant pile wall to perform as intended overlap must be maintained between the primary and secondary piles.
- Specified pile diameter and spacing (which define the theoretical overlap) must allow for installation tolerance.
- Tolerances to consider:
  - Accuracy of pile placement at the ground surface.
  - Verticality.
- Tighter tolerances than typical drilled shaft work.
- 80 feet has been considered the practical limit of installation.



TOLERANCE CONTROL

- Ground surface location
  - Survey alone (least accurate)
  - Guide trench
  - Template

Guide Trench



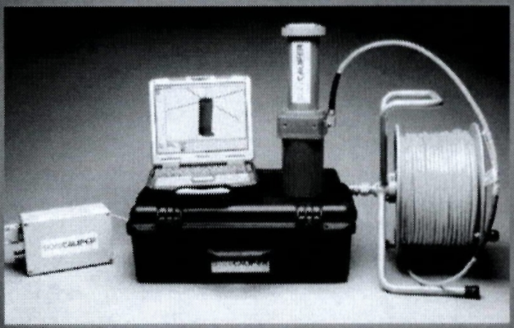
Template

TOLERANCE CONTROL

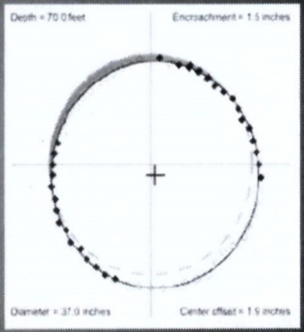
- Controlling verticality
  - Verify plumbness of the drill string when starting and during the drilling process.
  - Use of stiff drill string.
  - Downhole survey techniques.

DOWNHOLE SURVEY TECHNIQUES

- Sonicaliper® (Loadtest)



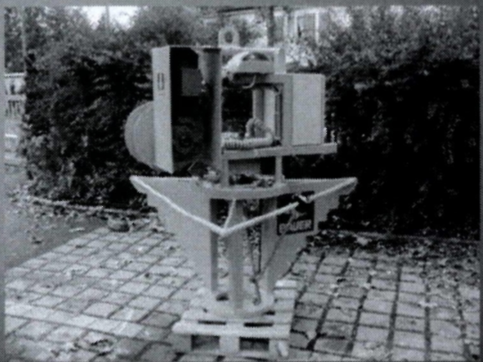
Sonicaliper® Instrument



Sonicaliper® Reading

DOWNHOLE SURVEY TECHNIQUES

- Inclination Measuring Instrument (Bauer)
  - Can be used to survey cased drillholes.
  - Similar to a large-scale inclinometer probe.

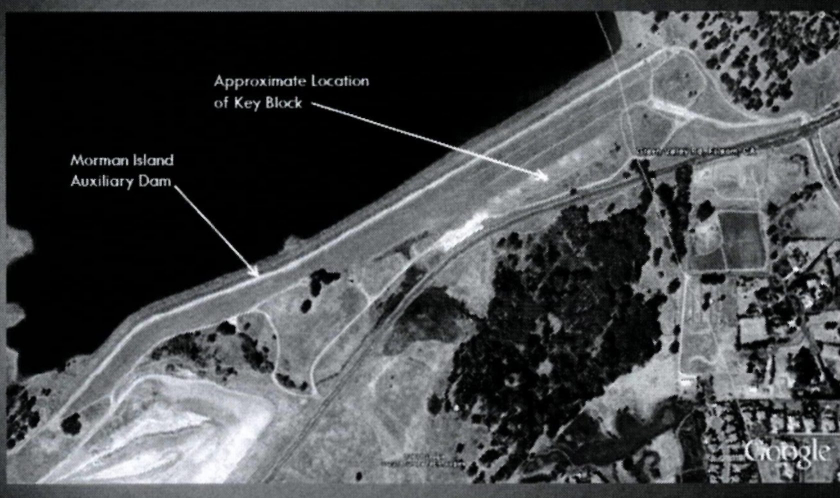


MORMON ISLAND AUXILIARY DAM KEY BLOCK

Project Overview

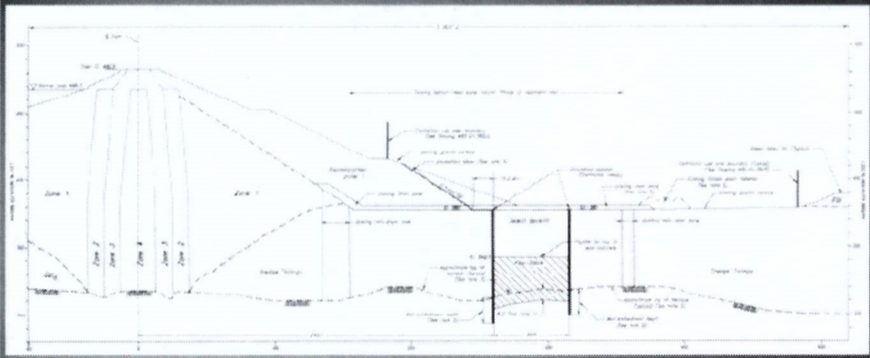
- MIAD is located about 20 miles northeast of Sacramento, California.
- 4800-foot long, 110-foot high earth dam that helps impound the American River to form Folsom Lake.
- United States Bureau of Reclamation (BOR) has determined that some of the foundation soils are susceptible to liquefaction during a large earthquake.
- BOR designed a 900-foot long by 55-foot wide "Key Block" downstream of the toe of the existing dam to mitigate potential problems resulting from liquefaction.
- Key Block excavation to be keyed into moderately weathered bedrock and backfilled with lean concrete and select fill.
- Owner: United States Bureau of Reclamation.
- General Contractor: Shimmick Construction.

MORMON ISLAND AUXILIARY DAM KEY BLOCK



Satellite View

MORMON ISLAND AUXILIARY DAM KEY BLOCK



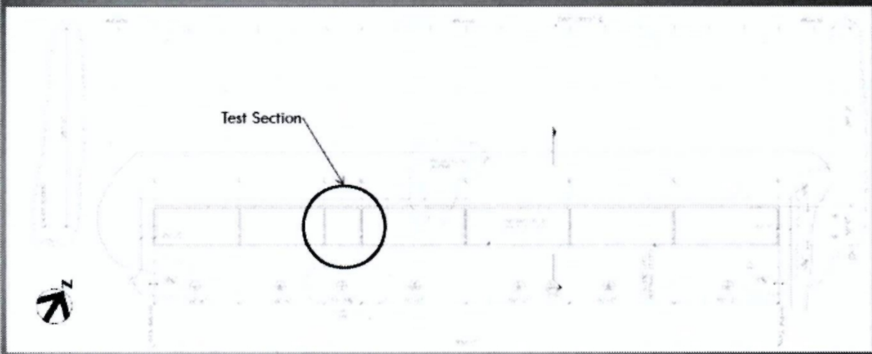
Contract Drawing - Section View

MORMON ISLAND AUXILIARY DAM KEY BLOCK

Geotechnical Conditions

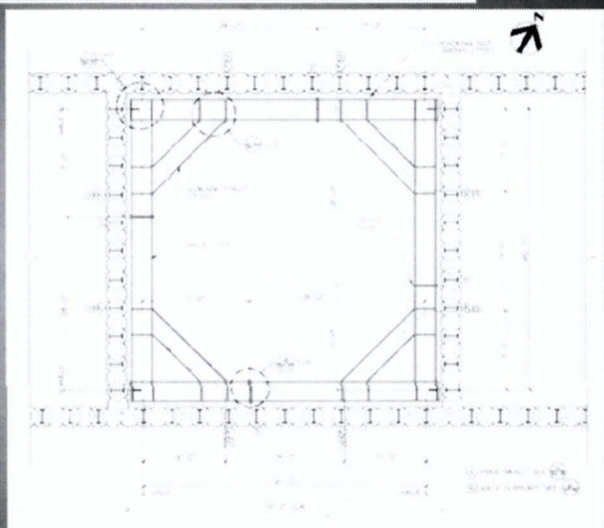
- Soil Profile:
  - Dredged alluvium: Sand and gravel with cobbles and occasional boulders. (Dredge tailings from old gold mining operations.) Material generally becomes siltier/finer-grained with depth.
  - Colluvium: Sporadic thin deposit of gravelly clay sitting on the bedrock in some borings.
  - Soil mass in the area of the Key Block was previously treated with thousands of bottom feed stone columns.
  - Bedrock: Amphibolite Schist. Typically intensely fractured with steeply dipping schistosity. Variably weathered. Hard where relatively fresh and very soft to soft where intensely weathered. Anticipated to have very low permeability. Depth to bedrock ranges from about 52 to 72 feet.
- Groundwater:
  - Typically within 5 feet of the ground surface.

MORMON ISLAND AUXILIARY DAM KEY BLOCK



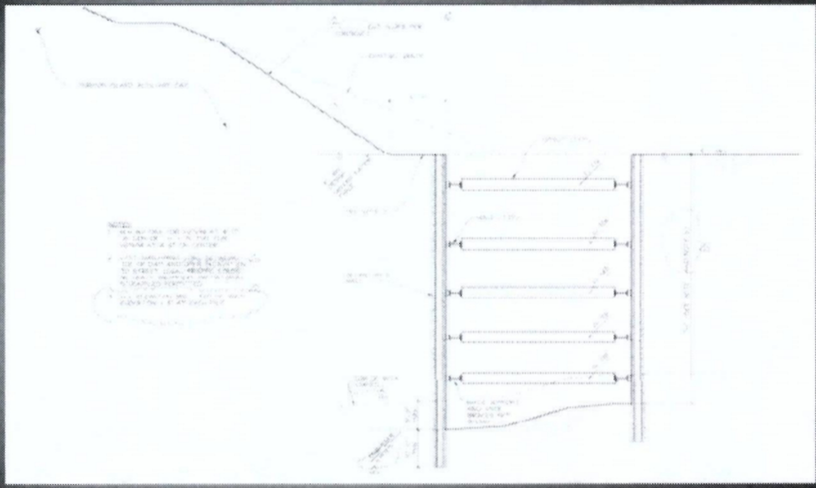
Secant Pile Wall Plan Layout

MORMON ISLAND AUXILIARY DAM KEY BLOCK



Detail Plan at Test Section

MORMON ISLAND AUXILIARY DAM KEY BLOCK



Typical Section

MORMON ISLAND AUXILIARY DAM KEY BLOCK

View Looking West

MORMON ISLAND AUXILIARY DAM KEY BLOCK

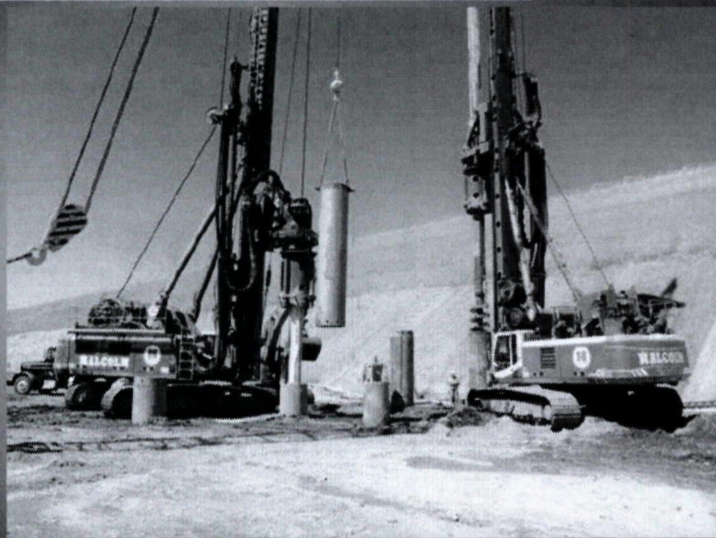
Test Section Secant Pile Construction

- Bauer BG40 drill rig used to install piles.
- Holes cased with sectional heavy wall casing. Casing oscillator used to extract casing.
- Sonicaliper® downhole surveys were performed periodically to confirm that verticality tolerance was being achieved.
- Holes tremie-concreted. Wide flange inserts stabbed into concrete-filled hole.
- During excavation, observations of the as-built piles indicated that installation tolerance was excellent. Seepage through secant pile joints was minimal.

MORMON ISLAND AUXILIARY DAM KEY BLOCK

Secant Pile Installation

MORMON ISLAND AUXILIARY DAM KEY BLOCK



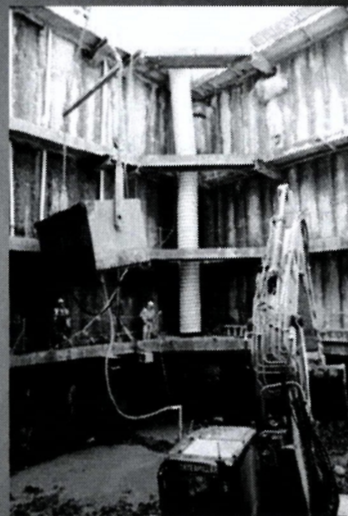
Secant Pile Installation

MORMON ISLAND AUXILIARY DAM KEY BLOCK

View from Top of Test Section Excavation

MORMON ISLAND AUXILIARY DAM KEY BLOCK

Secant Piles



Muck Box Being Used to Remove Soil

MORMON ISLAND AUXILIARY DAM KEY BLOCK

Bracing Levels 2, 3 and 4

MORMON ISLAND AUXILIARY DAM KEY BLOCK

Test Section at Full Depth

Test Section Shoring Performance

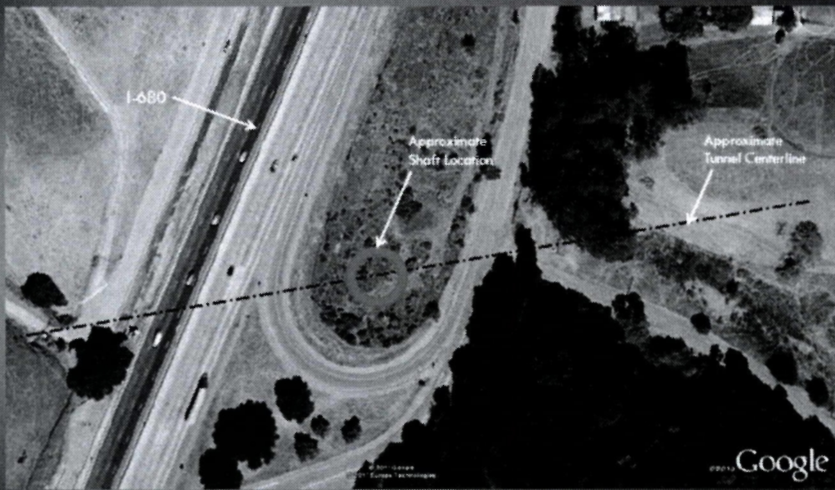
- Secant pile wall essentially watertight with up to 60 feet of hydrostatic head.
- Excellent drilling tolerance achieved under difficult drilling conditions.
- Secant pile wall was very stiff. Inclinometers indicated less than about ½" of deflection.
- Pre-fabricated bracing frames and concrete packing proved to be very efficient.

NEW IRVINGTON TUNNEL – VARGAS SHAFT

Project Overview

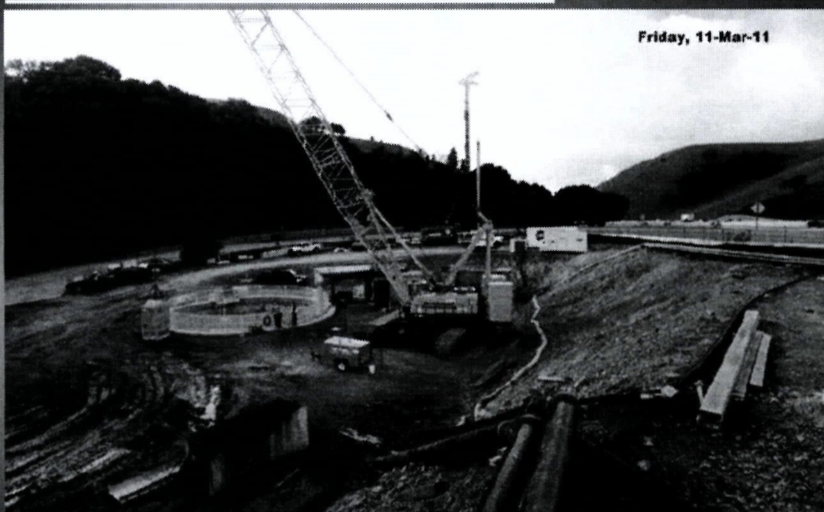
- 3.5 mile long New Irvington Tunnel being constructed to provide a seismically sound alternate to the existing tunnel which connects San Francisco's water sources in the Sierra Nevada and Alameda County to the Bay Area's water supply systems.
- Project includes a 115-foot deep, 41-foot diameter shaft to create access to drive the 13-foot diameter tunnel in two directions.
- Owner: San Francisco Public Utilities Commission.
- General Contractor: Southland Contracting/Tutor-Perini, JV.

NEW IRVINGTON TUNNEL – VARGAS SHAFT



Satellite View

NEW IRVINGTON TUNNEL – VARGAS SHAFT



View of Shaft Collar Looking South

NEW IRVINGTON TUNNEL – VARGAS SHAFT

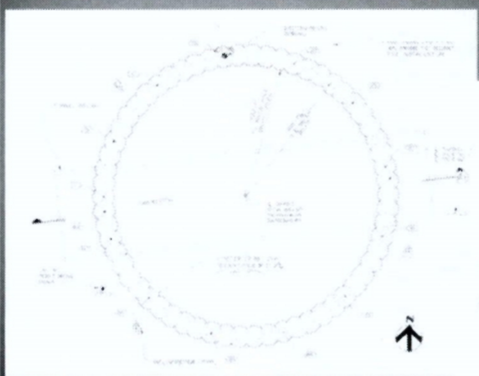
Geotechnical Conditions

- Soil Profile:
  - Fill: 10 to 20 feet of loose to very dense silty sand with gravel and cobbles.
  - Alluvium: about 20 feet of loose poorly graded sand with gravel and cobbles and medium stiff sandy lean clay.
  - Bedrock: anticipated to be about 5 to 8 feet of very weak siltstone overlying weak to moderately strong, highly to moderately fractured sandstone
  - Some shear zones in rock.
- Groundwater:
  - About 14 feet below ground surface.

NEW IRVINGTON TUNNEL – VARGAS SHAFT

Original Shaft Support Plan

- Secant pile compression ring penetrating a few feet into bedrock.
- Rock dowels and shotcrete installed in a top-down manner in bedrock.

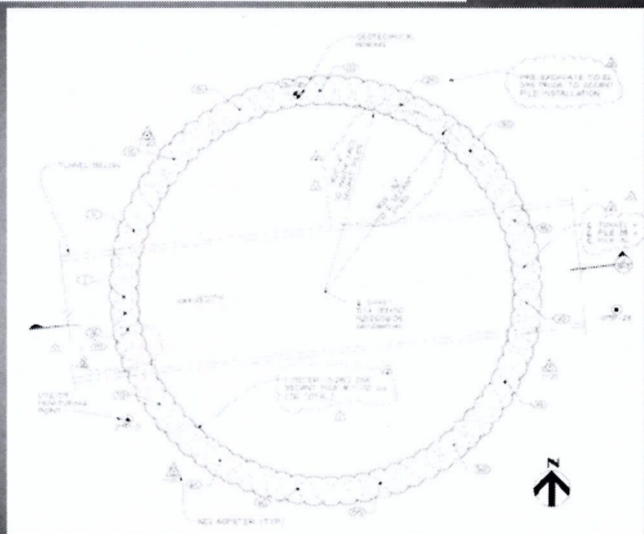


NEW IRVINGTON TUNNEL – VARGAS SHAFT

Revised Shaft Support Plan

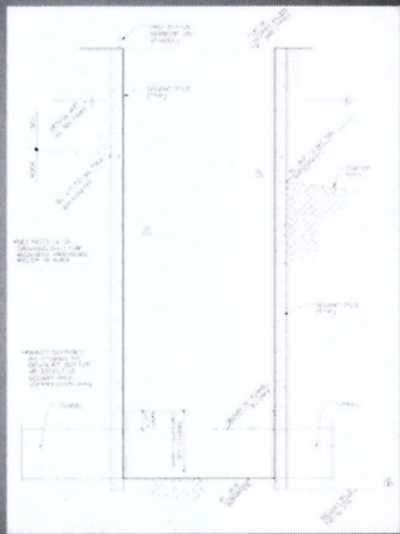
- During initial secant pile drilling it became evident that the top-down rock dowel and shotcrete support would be very challenging to install due to the quality of the bedrock being encountered to a depth of about 95 feet.
- Shaft support design was revised to extend the secant pile compression ring down to competent bedrock.
- Unprecedented depth of a secant pile compression ring.
- Concrete f'c = 3000 psi.
- Specified tolerances to maintain 5 inches of overlap between adjacent piles at a depth of 80 feet (in order to develop a 1.5-foot minimum thick effective compression ring).
  - Pile within 1 inch of theoretical location at ground surface. (Guide trench provided.)
  - 0.5% verticality tolerance.

NEW IRVINGTON TUNNEL – VARGAS SHAFT



Secant Pile Plan Layout - Revised

NEW IRVINGTON TUNNEL – VARGAS SHAFT



Shaft Section - Revised

NEW IRVINGTON TUNNEL – VARGAS SHAFT

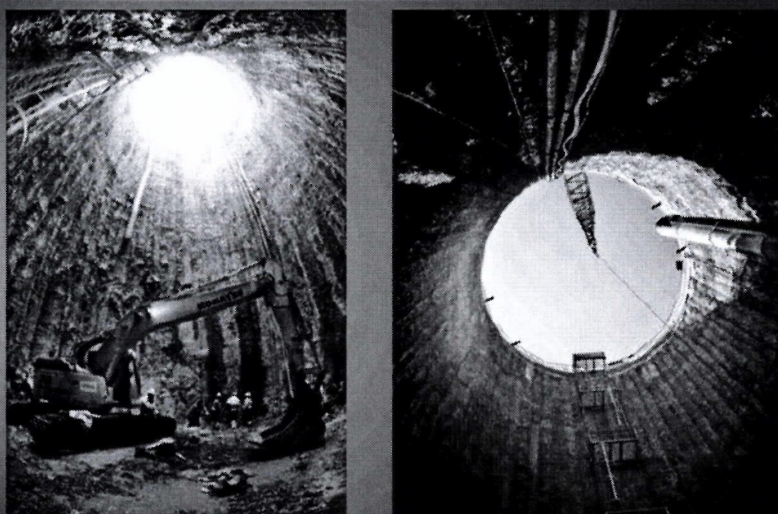
Shaft Construction

- Bauer BG40 drill rig used to install piles.
- Holes cased with sectional heavy wall casing to a depth of approximately 100 feet. Uncased hole in hard rock below 100 feet.
- Sonicaliper® downhole surveys were performed on every hole at depths of 60 and 90 feet. Surveys generally indicated that the verticality tolerance was well within the 0.5% limit.
- Holes tremie-concreted. As-placed concrete volume about 25% more than theoretical hole volume.
- During excavation, observations of the as-built piles indicated that, for the most part, installation tolerance was excellent.
- Weep holes provided through secant pile wall to relieve groundwater pressure in rock.
- Shaft successfully supported to a depth of 100 feet without any supplemental support.

NEW IRVINGTON TUNNEL – VARGAS SHAFT

Shaft Excavated to 90 feet

NEW IRVINGTON TUNNEL – VARGAS SHAFT



Shaft at Full Depth

CONCLUSIONS

- Drilling equipment and methods are now capable of achieving tolerances that allow secant piles to be used in geotechnical conditions and to depths previously considered to be unfeasible.
- Modern drill rigs and tooling allow cost-effective installation of secant piling excavation support systems suitable for depths up to 100 feet.
- Recently developed downhole survey techniques allow confirmation that critical drilling tolerances are met.

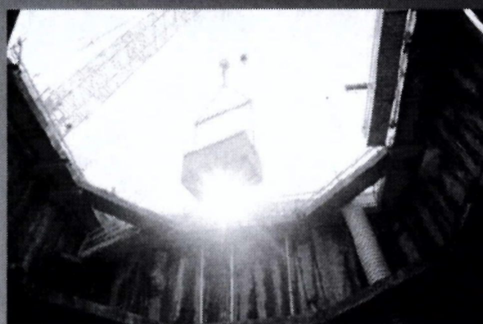
ACKNOWLEDGMENTS

MIAD Key Block

- Shimmick Construction
  Trace Porter, Project Manager
- United States Bureau of Reclamation

Vargas Shaft

- Southland/Tutor-Perini, JV
  Michael Cash, Project Manager
- San Francisco Public Utilities Commission and their consultants



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